VALLEY SEDIMENTATION IN NORTH CENTRAL MISSISSIPPI

by

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INTRODUCTION

The hilly part of the Yazoo drainage basin in north central Mississippi (fig. 1) is one of several sections of the United States where notable valley sedimentation is associated with culturally-accelerated soil erosion. It is an area of severe erosion of silty upland soils of loessial origin, and gullying of underlying Coastal Plain sedimentary formations which are mostly sandy.

Unusual severity of soil erosion in the area, and related valley sedimentation, were recognized within about 20 years after the country was settled and forests were cleared for agriculture. In 1860 State Geologist E. W. Hilgard reported: 1/

"..... large tracts ..... have already been irrecoverably lost to cultivation by washing. Not only is the soil ..... carried away from the hills, but the materials thus removed cover over the fertile branch bottoms, in company with a flood of sand, which renders them useless for all time to come.

"The difficulty ..... is of very frequent occurrence in this State ..... hillside washes are acquiring ..... an alarming importance."

The effects of valley sedimentation were further cited in a description of Marshall County: 2/

"In the smaller bottoms much cotton is grown, but they, as well as the adjacent uplands are liable to grievous damage from the cutting of gullies into the hillsides, undercutting the subsoil, and causing it, with the underlying sand, to be washed into the valleys, in some of which the original flood-plain is now covered with from 15 to 20 feet of sand, in which only willows, briers and Bermuda grass find a congenial existence."

1/ Hilgard, Eugene W. 1860. Report on the geology and agriculture of the State of Mississippi. 391 p., illus. E. Barksdale, State Printer, Jackson, Miss. (See p. 293).

2/ Hilgard, Eugene W. 1884. Report on the cotton production of the State of Mississippi, with a discussion of the general agricultural features of the State. U. S. Bur. of the Census, 10th Census U. S., 1880, pt. 1, p. 197-366, illus. (See p. 108, 110).

and concerning northwestern LaFayette County:

"Much and often irreparable damage has been done to the uplands as well as to the valleys of this part of the county by hillside washes, which soon cut through the loam subsoil into the underlying sand, baring the latter on the hills and deluging the valleys with it."

Conditions described by Hilgard persisted, no doubt with progressive worsening, and the area was chosen for initiation of a sedimentation research project of the Soil Conservation Service in 1935. Since that time soil erosion has apparently been greatly reduced, as a result of land use changes involving decreased cultivation, reforestation, and conservation programs including building of detention dams and farm ponds.

INVESTIGATIONS

In 1936-37 the modern valley sediments were sampled and measured by auger borings throughout the valleys of Toby Tubby and Hurricane Creeks near Oxford, the Tallahatchie River from the "delta" west of Batesville to its head northeast of New Albany, and Wilhite Creek, a tributary above New Albany. Valley cross-sections were surveyed and marked with iron pipes as a basis for future comparisons, and on some cross-sections concrete posts, two feet high, were set at intervals of 100 to 300 feet to provide visual record of future sedimentation. The Hurricane and Toby Tubby valleys (including Goose Creek valley, tributary to Toby Tubby) were studied most thoroughly and the findings were published in Technical Bulletin 695 of the Department of Agriculture.3/

During 1939-41 similar but less complete sedimentation surveys were extended throughout other valleys tributary to the Tallahatchie, and other representative parts of the Yazoo drainage system. That was done by Soil Conservation Service personnel assigned to Department of Agriculture surveys for "run-off and waterflow retardation and soil erosion prevention," usually called "flood surveys." Sediment depths and areas were determined chiefly by R. D. Holt and L. O. Rowland, and cross-sections were surveyed by parties under F. E. Tardy and John White; Gordon Rittenhouse of the SCS Research Division served as technical advisor. The "flood survey" program was terminated because of World War II and whereabouts of much of the sedimentation data is now unknown, but some data have been preserved in SCS files. The "flood surveys" are included among valleys represented on Figure 1, and Table 1 includes flood survey data for Tallahatchie tributaries, recorded in an unfinished draft report prepared by Dr. Rittenhouse in 1939. 4/

3/ Happ, Stafford C., Gordon Rittenhouse and G. C. Dobson. 1940. Some principles of accelerated stream and valley sedimentation. U. S. Dept. of Agr. Tech. Bull. 695, 134 p., illus.

4/ Rittenhouse, Gordon. 1939. Sedimentation report, Tallahatchie Watershed Survey. U. S. Soil Cons. Ser., 55 p., illus. Unpublished manuscript report.

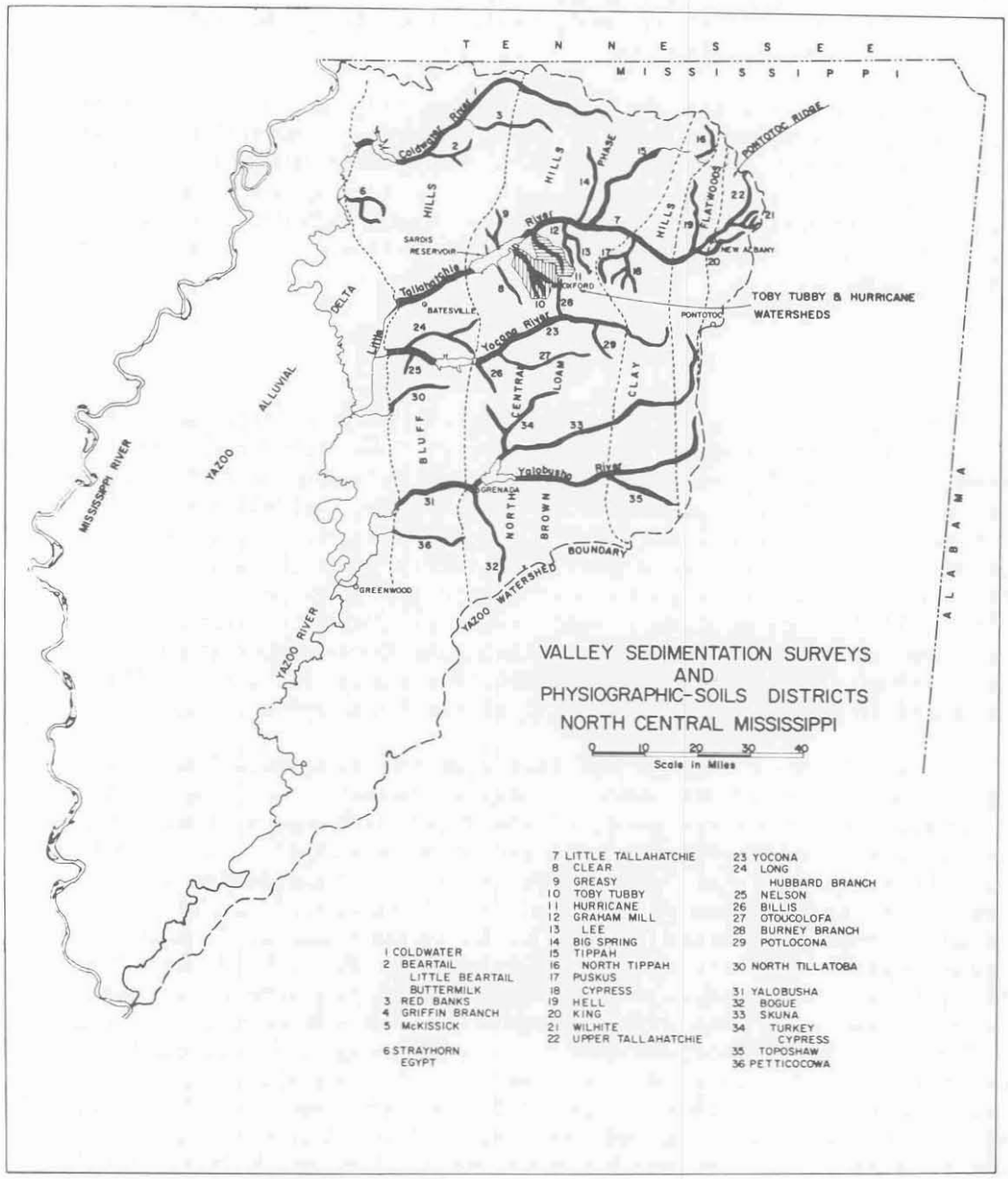

Figure 1. --Location of valley sedimentation surveys in the hill section of the Yazoo drainage basin, north central Mississippi.

Table 1. --Modern flood plain sediment in valleys tributary to Little Tallahatchie River, according to 1937-39 boring surveys.

Physiographic District and Valley	Drainage Area[1]	Modern Sediment[2]			Minimum Indicated Erosion[3]
		Area	Volume	Av. Depth	
	(sq. mi.)	(acres)	(ac.-ft.)	(feet)	(inches)
Brown Loam Area					
Toby Tubby Creek[4]	56.5	2,915 (4,817)[2]	9,035 (12,839)[2]	3.1 (2.7)[2]	3.2 (4.9)[2]
Hurricane Creek	32.1	1,374 (2,160)[2]	5,223 (7,043)[2]	3.8 (3.3)[2]	3.3 (4.6)[2]
Clear Creek	44.7	982[5]	[5]	3.4	[5]
Greasy Creek	19.5[6]	2,735[6]	6,733[6]	3.0	7.5
Graham Mill Creek[7]	11.1	855	3,376	3.9	6.5
Lee Creek[8]	19.1	1,020	4,554	4.5	4.9
Big Spring Creek	55.9	4,176	15,545	3.7	5.9
Clay Hills					
North Tippah Creek	24.9	3,072	3,496	1.1	3.2
Puskus Creek	30.2	2,843	3,735	1.3	2.7
Cypress Creek	29.5	2,316	2,662	1.1	2.0
Flat Woods					
Hell Creek	37.5	5,290	4,990	0.9	3.2
Pontotoc Ridge					
King Creek	24.8	1,933	2,998	1.6	2.6
Wilhite Creek	15.9	1,732	2,109	1.2	3.0
Upper Tallahatchie (above New Albany)	42.8	1,664 (3,247)[2]	2,256 (3,262)[2]	1.4 (1.0)[2]	1.1 (1.4)[2]

1/ Drainage area includes area of sedimentation.

2/ Sediment data based on measurements only on flood plain and principal branches, except no branches included for Clear Creek, North Tippah Creek, or Upper Tallahatchie. Additional sediment is present on smaller tributaries, but has been estimated only for Toby Tubby and Hurricane Creeks and Upper Tallahatchie, for which data including these estimates are given in parentheses.

3/ Indicated erosion is computed only from measured modern valley flood plain sediment, divided by drainage area exclusive of that part on which sediment is computed. No allowance is made for erosional debris remaining on hillside slopes, or sediment carried beyond the immediate valley; nor for sediment in minor tributary valleys except the Toby Tubby, Hurricane and Upper Tallahatchie data given in parentheses.

4/ Data for Toby Tubby Creek includes tributary Goose, East and West Coose Creeks.

5/ Sediment areas used in 1939 computation for Clear Creek appear too small, hence invalidating any figures which might be derived for volume and indicated erosion.

6/ Sediment data for Greasy Creek include 1,487 ac.-ft. on an alluvial fan of 992 acres built into Little Tallahatchie valley, not included in Greasy Creek drainage area.

7/ Graham Mill Creek was listed as Lee Creek in 1939 survey data.

8/ Lee Creek was listed as Fullysucky Creek in 1939 survey data.

The valley cross-sections in Toby Tubby, Goose and Hurricane valleys were resurveyed by Agricultural Research Service in 1965. In 1966 some additional sections, established by the Army Corps of Engineers in 1947, were resurveyed to provide partial data for a shorter period. Data also are available from 1954 resurveys by the Soil Conservation Service on some of the 1937 Goose Creek lines.

CHARACTERISTICS AND DISTRIBUTION OF MODERN SEDIMENT

In headwater sections of the valleys a dark soil horizon was commonly found, buried a few feet beneath lighter-colored, brownish, usually sandy and often clearly stratified sediment. The buried dark soil could be traced laterally into obvious continuity with surface soils of the valley sides. Farther down the valleys the buried dark soils were discontinuous or less conspicuous, but contrasting pale colors and abundant small hard concretions were commonly found at depths consistent with underlying old subsoils found where the dark topsoil was recognizable. With these criteria it appeared possible to recognize and measure the approximate thickness of modern flood plain sediment throughout the creek valleys. This thickness was generally much less than might be anticipated from Hilgard's 1860 and 1884 reports, however. Instead of 20 feet or more, as might be expected from continued accumulation since 1884, it was rarely possible to identify as much as 10 feet of modern sediment, in most places there was less than 5 feet, and the average was only 3.5 feet.

The 1937 surveys showed Toby Tubby-Hurricane modern sediment was chiefly silt (55 percent), with 30 percent sand and 15 percent clay. The thickest deposits and greater part of the sediment had accumulated in upper parts of the valleys, particularly in local concentrations on alluvial fans at mouths of tributaries and in "valley plug" areas upstream from completely-filled sections of stream channels. The channel filling forced all flow overbank with resultant deposition of practically all bed load, covering adjacent parts of the flood plain with infertile sand, and causing extensive swamping and agricultural damage extending upstream from the "plug." Some channel occlusions had formed near lower ends of artificially-straightened sections, and some where unusually large alluvial fans had been built from the mouths of tributaries; but others had formed in natural channels where apparently unaffected by any outside influences.

The downstream thinning of sediment continued to the Tallahatchie flood plain, where modern deposits were estimated to average no more than one foot in thickness. Only in a few places was as much as two feet of modern sediment recognized, and in many places none could be distinguished on the Tallahatchie bottoms.

The "flood surveys" showed generally similar magnitude of valley sedimentation throughout the hill portion of the Yazoo basin, but with highest rates and greatest agricultural damage in a part of the North Central Hills where streams have been most affected by sand from hillside gullies, as in Toby Tubby and Hurricane valleys.

Resurveys of Toby Tubby and Hurricane valley cross-sections in 1965 show that the sedimentation rate has decreased but areal distribution and flood plain aggradation have continued in about the same pattern as before 1937. Greatest deposition has continued to be in upper parts of the valleys, and on "valley plugs." All of the 1937 plugs have persisted; some have been partly dissected by headward extension of newly-incised channels developed from below, but such erosion is slow in cohesive old silts underlying the modern flood plain sediment. Several new plugs have formed, although not enough is known of the intervening history to judge whether some are new or only upstream extensions of those existing in 1937. One new plug may have been caused by a beaver dam. Beaver have been introduced to the area since 1937, and have aggravated swamping on several of the older plug areas.

One significant change in sediment distribution has occurred in the lower few miles of Toby Tubby and Hurricane valleys, which since 1940 have been inundated during part of each year by Sardis Reservoir flood storage. There the cross-sections show an average increase of about 30 percent in sedimentation for the 1937-65 period in comparison with the pre-1937 average. Despite this relative increase, however, the average thickness of deposition has been only about 7 inches since 1937, which is still slightly less than the average for all of Toby Tubby and Hurricane valleys.

Stream channel changes could not be measured by the 1937 boring survey methods. During the 1937-65 period, however, channels have not changed appreciably in average width, nor aggraded appreciably on the average although there have been many erratic variations. Many and perhaps most of the variations are related to headward progression of channel plugs, and corresponding local degradation below the plugs. There has also been a general tendency to deepen channels near the heads of the valleys, at least partly because of reductions in supply of sand from gullies, and there has been consistent building up of channel beds at the lower ends where affected by Sardis Reservoir impoundment. In Toby Tubby valley the 1937-65 average channel aggradation has been 1.2 feet, about twice the average overbank flood plain aggradation, but most of the channel filling is in the lower part within the Reservoir flood storage pool. Hurricane and Goose Creek channel beds have both been aggraded appreciably in some places, and degraded in other places, but have not changed appreciably in average elevation; in effect, therefore, the banks have been raised about 0.7 feet, the average amount of overbank aggradation.

SEDIMENTATION RATES

Average thickness of 1937-65 sedimentation on the Toby Tubby and Hurricane valley cross-sections was about 0.7 feet. This is equivalent to a reduction of about 35 percent from the average rate estimated from 1937 borings for the preceding 100 years of culturally-accelerated soil erosion and sedimentation. There can be no doubt, however, that the reduction in upland erosion and valley sedimentation has been more than 35 percent since 1937, for it seems probable that the rate

prevailing in 1937 was more than average for the preceding 100 years, and from observation it also seems reasonably certain that the present rate is less than the average for the 28 years from 1937 to 1965.

In an attempt to evaluate changes within the 1937-65 period, resurveys were made in 1966 on 13 valley cross-sections established by the Corps of Engineers in 1947. Six of these cross-sections are quite well distributed throughout Toby Tubby valley and four throughout Goose Creek valley, but the only 3 on which comparisons can be made for Hurricane are in the downstream half of that valley. Sedimentation rates for the 1947-65 period have been compared with 1937-65 rates on nearby SCS lines, and 1937-47 rates derived by difference. These comparisons indicate an average 1947-66 rate about 40 percent less than the average for 1937-47.

Also, eight cross-sections of Goose Creek valley and its tributaries were resurveyed by the Soil Conservation Service in 1954, 5/ and show average 1954-65 sedimentation 24 percent less than for the 1937-54 period. Although this represents a small part of the area, it does furnish additional support for the trend toward lower rates shown by comparisons with the Army Engineers' sections which are more widely distributed.

In view of these lines of evidence and reasoning, it seems probable that soil erosion and valley sedimentation rates have been reduced at least 50 percent since 1937.

RELATION TO SARDIS RESERVOIR SILTING

Construction of Sardis Reservoir on Tallahatchie River was anticipated when the valley studies were begun, and the relationship between soil erosion and future reservoir silting was a factor in the planning. The upstream concentrations of sediment found by borings, with relatively thin modern deposits on the Tallahatchie flood plain and within the reservoir area on lower parts of tributaries, together with relatively small sediment concentrations measured by random and short period suspended load sampling on the Tallahatchie and lower parts of several tributaries, indicated that the reservoir silting rate would be relatively low. That indication has been fully confirmed by subsequent reservoir surveys which show only 1.3 percent capacity loss in the first 20 years of reservoir operation. 6/

5/ Woodburn, Russell. 1955. Sediment production in small watersheds. Agric. Eng., v. 36, No. 7, p. 467-470, 473, illus.

6/ Report on sedimentation surveys, Sardis Reservoir, Little Tallahatchie River, Mississippi. 1966. Vicksburg District Corps of Engineers, Department of the Army, Vicksburg, Miss. 9 p., illus. (data revised Dec. 1967).

It has already been mentioned that cross-sections within the reservoir flood storage pool in lower Toby Tubby and Hurricane valleys show an apparent sedimentation increase of only about 30 percent since 1939, just a year before reservoir closure. Even less reservoir influence is suggested by measurements on 100 concrete aggradation gages spaced along 3 lines across the Tallahatchie flood plain within the reservoir. During 1936-39, before reservoir closure, the average rate of deposition on those gages was about 0.02 feet/year, and for the period 1939-67 the average was only 0.44 feet, or slightly less than 0.02 feet/year. One of these lines is between the mouths of Toby Tubby and Hurricane Creeks, at approximate head of the permanent conservation pool, and has been submerged most of the time since 1940; the other two are about 2 and 7 miles upstream, within that part of the flood storage pool submerged during part of most years. Of course comparison based on only 3 years before reservoir closure may be subject to considerable variation from longer averages, but the apparent negligible effect of reservoir impoundment must be considered surprising.

CONCLUSIONS

These investigations have shown much less modern valley sediment than might be expected from reports concerning conditions during the earlier years of agriculturally-accelerated soil erosion. Even so, the most significant finding may be the tendency of sediment to be concentrated in upper parts of the tributary valleys, partly because of sand filling of stream channels. These conditions are important to understanding of the relations between soil erosion and reservoir silting or other downstream sedimentation. Also important is the reduction in sedimentation rates since 1937, which is believed due chiefly to changes in land use, including reforestation, and soil conservation programs including reduced cultivation of sloping lands and construction of many detention dams and farm ponds.